these chapters, and in a few places elsewhere, appear drab and almost pedestrian by contrast with the excellent and lively discussions given in the historical part. There, rather than simply presenting the same old equations in their historical (instead of logical) order, as history of physics texts are wont to do, Cropper presents us with persons who invented the equations. The personal sketches are brief, but they give clear and intimate, and somehow very real, pictures of the men involved.

Instead of interrupting the text with footnotes or problems, Cropper has collected all notes, comments, bibliography and problems in a section at the end. It makes excellent reading, and it may even be worth getting the book just for this part. Interesting sidelines of the text are amplified here; each of the references is placed in a context, and the problems, after an admittedly cursory examination, appear interesting and well suited to the audience.

Cropper's book would thus appear to me an excellent supplementary text for part of a course on quantum mechanics for middle or upper level undergraduates; the instructors, too, will find it, on the whole, enjoyable and informative.

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Introduction to the Theory of Linear Systems

By E. A. Faulkner
89 pp. Barnes and Noble (Chapman and Hall), New York, 1969. $3.25

Linearization has been frequently employed to simplify the mathematical treatment of complex problems. "Natural" physical systems, such as optical, dielectric and viscoelastic systems, are generally linear and time-invariant only within a limited interval of excitation and reaction. Only "man-made" systems, in particular, electrical networks, exhibit the type of linearity and constancy that is the joy of the applied mathematician. This probably is one reason why their theory has reached such a high degree of perfection.

To describe the general pattern of behavior of a time-invariant linear system, one does not have to write down in detail its differential equations; it is enough to know that they are linear. The system is then characterized by its response to specified, simple types of external excitation. With the aid of the "response" function, the behavior under all possible conditions of external excitation can be calculated. From this point of view, one considers the system as a "black box," with input and output ports, and one investigates its reactions without opening it. The response function contains information on how the box behaves and, within restrictions, on what is, or might be, in it. With the use of integral transforms and the generalized theory of analytic functions, the theory has been built into a general self-contained structure.

Under the cover of different terminologies, the methods of system theory have been independently developed and applied in many areas of physics and engineering; specialists working in a particular field have frequently been insufficiently aware of how far the general theory has progressed. An easily understandable exposition summarizing the general principles and main results of the theory should therefore be useful for both the nonspecialist, who wants to acquire some general information on the theory, and for the specialist, who likes to have a handy collection of the basic equations.

E. A. Faulkner, who is senior lecturer in physics at the University of Reading and author of *Principles of Linear Circuits* obviously has been aware of this situation. With the present monograph he provides students with a general insight into the methods of modern system theory, the properties of linear circuits and the applications of the Kronig–Kramers relations in electrical network problems. For the trained electronics engineer he presents a summary of the main results.

The author starts with a formulation of basic concepts: causality, time-invariance and stability. From them he derives the properties of the system function and the convolution, or superposition, integral. Subsequently, Fourier and Laplace transform methods and the inversion integral are discussed. In discussing the frequency response function one deals with wave filters and minimum-phase systems and defines the concepts of group delay and signal-front delay. Methods of complex integration are used to derive the Kronig–Kramers relations, whose generalization has become so important in modern dispersion theory, and also to derive the gain–phase relationship. The last chapter deals with negative-feedback systems, problems of stability and the Nyquist stability criterion.

The treatment is authoritative. The book covers a very wide area in methods and applications. It is a small book so that exposition had to be informal and is not entirely uniform in detail and depth. Only rational functions and lumped-parameter systems are explicitly discussed. The theory of equivalent circuits for "marginally stable" systems, that is, pure reactance systems, is not included and the method of analytical continuation might have deserved a slightly more careful consideration. I would have liked a more extensive list of references. These omissions, if they are such, do not however affect the book's usefulness as a source of information for the general physics student and as a self-contained compendium for the practical engineer.

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Francis Bitter, Selected Papers and Commentaries

T. Erber, C. M. Fowler, *eds.*
551 pp. MIT Press, Cambridge, Mass., 1969. $20.00

The American physicist Francis Bitter (1902–67) published about 90 articles and five books, mostly on magnetism. This commemorative volume reprints 33 of the articles, grouped in eight subject categories, with commentaries by J. H. Van Vleck, L. Néel, A. Kastler and other experts. A short biography by T. Erber effectively uses quotations from Bitter's own autobiographical book, *Magnets*; a longer selection from this book, "Degaussing the Fleet," is also reprinted to indicate some of Bitter's activities during World War II. Thus, the book not only includes a valuable collection of original source materials for the expert, but also provides some general perspective and evaluation for the general reader.

According to the commentaries, Bitter's major achievements were in the development of new experimental methods involving magnetic fields. In many cases, having shown how his technique could yield valuable information (for example, about atomic structure), he left the further exploitation of the technique to others and moved to a differerent topic. (Thus it was A. Kastler rather than Bitter who received the Nobel Prize for research growing out of the "double resonance" experiment first done successfully at MIT by Jean Brossel and Bitter.)

Bitter also wrote on the theory of magnetism, but the experts do not seem to consider his contributions as being especially profound or memorable. A paper entitled "The diamagnetism of electrons in metals," published in 1930, contained an expression for the diamagnetic susceptibility of a quantum-electron gas similar to the one derived more accurately by L. D. Landau in the same year; but this paper is omitted from the present volume, and Bitter's anticipation of what is generally known as "Landau diamagnetism" is nowhere mentioned.

In his article on "The Scientist's Social Responsibility," published in 1946, Bitter advocated the use of the "scientific method"—quantitative techniques such as operations research and game

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theory—in solving social problems. Although recognizing that some social problems may be caused by science itself, he did not even mention the possibility that new discoveries and inventions might be suppressed for fear of their consequences. In response to the threat of nuclear bombing, he proposed research on population dispersal.

Obvious difficulties exist in making a selection of a scientist's works that will satisfy everyone. But it is better to make the attempt (assuming the scientist is not so important that *all* his works should be reprinted) than to publish only a miscellaneous collection of essays by his colleagues and students (the usual *Festschrift*) or nothing at all. This volume sets an excellent example that should be followed by others in the future.

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Advances in Atomic and Molecular Physics, Vol. 5

D. R. Bates, Immanuel Estermann, *eds.*
432 pp. Academic, New York, 1969. $18.50

This volume continues an excellent series of collected monographs. Topics are timely and the work is current.

As with earlier issues, experimental and theoretical contributions are commingled. In the experimental group are chapters on flowing afterglow measurements of ion–neutral reactions by E. E. Ferguson, F. C. Fehsenfeld and A. L. Schemltekopf; on reactions between merging beams with small relative energies by Roy H. Neynaber; on radiofrequency spectroscopy of ions stored in field cages by Hans G. Dehmelt, and a review of spectra from molecular solids by O. Schnepp.

In the theoretical group are chapters on the calculation of atomic phototransition probabilities by R. J. S. Crossley; on relativistic corrections to atomic energy levels by Holly Thomis Doyle; on collision broadening as viewed in terms of a classical analog by A. Ben-Reuven, and on tables of one- and two-particle coefficients of fractional parentage by C. D. H. Chisholm, A. Dalgarno and F. R. Innes. The included subjects continue the pattern of earlier volumes, where collision mechanics and photoprocesses are established themes.

The first two papers describe complementing methods to obtain ion–molecule reactive cross sections at thermal energies. The afterglow studies have been particularly fertile to the nurture of useful aeronomic data; the more sophisticated merging-beam techniques promise and achieve increased insight by better defining the collision mechanics. The chapter on radiofrequency spectroscopy continues an earlier monograph by the same author, published in volume 3; most readers will need to refer to this earlier paper. The radiofrequency experiments described in the present volume are exceptionally elegant and precise. This technique, too, could be informatively applied to studies of low energy ion–molecule reactions from well defined collisions.

The chapters on atomic transition probabilities and on relativistic corrections to atomic energy levels are very readable and mutually complementing. Interested readers will also wish to review A. L. Stewart's monograph in volume 3. The section on spectra of molecular solids reviews the dynamical information derivable about simple molecules from infrared spectra of their condensed phases.

The contents of this volume are, for the most part, reported as current and continuing rather than reflective and archival. It is an attractive feature of the "Advances" format that presentation styles may vary as appropriate to the relationsip of the authors to their work. In several chapters, the authors are themselves pre-eminent contributors to their fields, and these chapters properly read in part as chronicles of a laboratory as well as of a physics speciality. In other sections, the more usual review style is followed. It is perhaps a concomitant penalty of the format that the several authors do not address a common readership. It is my opinion that most readers, expert in some speciality of physics, will seek in the monographs authoritative introductions into specialities in which the readers are not themselves expert. If this is so, generously discursive introductions are mandatory. In some of the articles, however, a too telegraphic brevity echoes habits formed when the authors have written for journals.

These failings, if failings they be, are exceptions in an otherwise excellent compendium. The volume deserves a place in the private libraries of working physicists.

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Phase-Space Dynamics of Particles

***By* A. J. Lichtenberg**
331 pp. Wiley, New York, 1969. $16.00

This is a unique book indispensible for the physicist concerned with accelerators or plasma physics. Going well beyond the cliché "filling of a gap" in the literature, it ties together many islands of physics that previously have been documented only in rather limited ways.

Allan Lichtenberg formerly worked in accelerator physics during the design and construction of the Cambridge Electron Accelerator and later became active in plasma physics; he is currently professor of electrical engineering at the University of California, Berkeley. Like